

Antiflooding prevention, protection, strategic environmental planning of aquatic resources and water purification: The case of Thessalian basin, in Greece[☆]

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ABSTRACT

In the E.U. following the old 5th Environmental Action Program (EAP) of 1994 and the new 6th EAP for the sustainable development in 2001, we confront the strategic management problem of aquatic resources at the regional and watershed level. *What should be the goals for a new strategic management of natural and aquatic resources in a Region of Greece such as Thessaly?* The present paper is concerned with the protection, prevention and strategic environmental planning of aquatic resources and water purification in the Thessaly basin as well as the protection of these resources from the pollution and depletion, which might result from various national water resource programs and plans which are already in operation. The aforementioned aim is a product of research on the goals, actions and proposals, which depict the problem of aquatic resource management related to pollution, the link with agricultural activities and the overall problem of water. Primarily, a general profile of the water situation and problems is presented for the Thessaly basin, including water pollution and the problems related to the rational management and protection of aquatic resources. Also, the prevention of natural water-involved disasters is explored which in turn points to the need for a new strategic scheme for environmental management of aquatic resources and purification and to the institution of new water policy actions and measures for the Thessaly basin in central Greece.

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1. Introduction

In 1994, the 5th EAP pursued the incorporation of environmental policies into direct and short-term implementation, and into other policies focused upon the ten environmental problems (issues or goals), in the 4 financial sections. The political pursuits and the recognized goals which had to be achieved by 2000 were defined in the 5th EAP. One of the ten goals was water management and the public environment [1]. In May 2001, a new strategy for sustainable development was announced by the E.U. [20]. Here all the goals were defined for long-term development with a focus primarily on 4 sectors and including priorities until 2010: the handling of climate changes, nature and biodiversity, environment and health, management of natural resources (NR) and waste. Great attention has been given especially to aquatic resources [4,6,16,20]. In order for these goals to be achieved, we propose the following action lines: improvement in the implementation of environmental legislation [16,19,20], cooperation between the market and the citizens and increase in the incorporation of environmental protection in other community policies [2,3,8,21].

So the question is raised: *what goals and actions should be incorporated in the new strategic management of natural and, aquatic resources, including water purification, in a Greek Region, like Thessaly?* To answer this question would require an evaluation of the overall condition of the water, as depicted in various national programs/plans which focus on management problems as well as on environmental pollution. Also rational management problems, NR protection and prevention of natural disasters—antiflooding protection must be organized. Finally the needs and goals for a new strategic environmental management of natural-aquatic resources and water purification and for the institution of new water policy actions and measures in Thessaly basin in central Greece are discussed.

2. Thessaly: A general profile of aquatic resource problems

Thessaly has relatively insufficient, but significant quantities of aquatic resources of high quality and simultaneously there are major environmental problems regarding their best and sustainable management. The basic causes of problems in water utilization in Thessaly are: a) the irregular spatial distribution of aquatic resources b) the unequal spatial and temporal distributions of demand by water users, c) agricultural activities—the biggest consumer of usable water (87%), d) the morphology of the area, e) the dependence of Northern area upon the surface drainage rivers, f) the extensive coastal line and g) the many small islands with inadequate aquatic resources [2,4].

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While a related board for the “management of country's aquatic sources” was created in the recent “operational environmental program for sustainable development” (EP.PER.S.D.2006-2013) [2], we still encounter 5 aquatic departments with deficiencies and/or at the limits of supply and demand. Thessaly (Fig. 1) is one of these regions.

In the present profile we encounter problems that concern the management of water at the national level, for example, the inadequate monitoring of usages and users of waters and the lack of coordination among the administrators. There is an opportunistic utilization of isolated aquatic resources, while there is also a lack of incentives – ant incentives for economies in the use of water, especially in agriculture. Also, aquifers are an important source of drinking water and these sources are vulnerable to contamination [4,17]. Heavy rains, irrigation methods and flooding also affect the amount of nitrate that reaches both ground and surface water [8,21].

The lack of politically inspired penalties for wasting water is reflected in the scarcity of this source. Special interventions by the legislature can be found, regarding nitrogen concentrations in underground waters of Thessaly [4,6,8,9,13]. Efficiency of investment in preventive measures, on agricultural pressures and practices, or on domestic and industrial discharges, will have to be evaluated and compared [20]. The source of the above problems is the weakness in the SWOT analysis and in the delay in applying the national law 3199/03, which coordinates with 2000/60/E.U [19], and with the proof of cohesion, which is symbolized by the strategy and the priorities of the present national and European operational program [2]. The EU water framework directive (2000/60/EC) aims to get polluted water clean again, and to ensure that clean waters are kept clean [4,6,8,9]. From the ‘Regional environmental strategic plan for the sustainable development of Thessaly’ (RESP of SD) [5], we may recall: “In order to sustain the programming horizon of 2010, and the productive ability and viability of Thessaly and its residents, we demand as a first priority the completion of the plans for the surface aquatic resources in Thessaly (Smokovos, Karla, Girtoni, etc)”, as well as the implementation of rational management systems for surface and groundwater and for irrigation systems, including parallel interventions for sustainability of the irrigation areas, measures to ban and control drilling, to

reform cultivation and other activities, including agricultural and stockbreeding production systems, especially in the plains. These measures are also required to maintain the sustainable functioning of the Pinios River and its parallel torrents [5]. At another point, we underline the lack of administrative measures. At present there is no irrigation program, as a result, of which problems are created for farming, and for the state services involved (TOEB). The lack of administrators in similar areas is a common phenomenon. All of the problems that have been highlighted for periods of low rainfall (drought) are becoming more intense, with “unconceivable ramifications”. Also, in the frame of regional planning and its proposals for the time horizon 2006–2017, we encounter another proposal for the integrated management of aquatic resources up to 2017 [7]. Especially, as far as the 2000/60 regulations are concerned, we must report that so far the coordination with Greek legislation (Law 3199/2003) has been completed, and that legislation related to programs and measures for 4 regions has also been completed, which includes the implementation of management plans for river basin in 3 other regions, as well. It is noted that “for the implementation of the total regulation demands we are lagging in a major number of actions which must be taken in future time” [2].

3. The scarcity of water and the problems of pollution in Thessaly can be dealt with through rational management and strategic protection planning of aquatic resources

The quality of surface waters is generally in a good state with some exceptions [8,9]. But as confirmed, by the new EP.PER.S.D. 2006–2013, all the above have not yet been applied to agriculture [2]. According to the regulation 91/676/EU “for the protection of waters from pollution caused by agricultural activities”, Thessaly is characterized as a sensitive zone [6] (Greek law 99652/1906/99). This includes all measures taken for land protection, the “codes of rational agricultural practice” and the action program for their promotion and application. A national network of monitoring, organized by the Ministry of environment, regional planning and public works (Y.PE.XO.DE) has been functioning since 1998 and offers a chemical analysis and the time fluctuations of certain quality points, but it does not include the biological points of quality or



Fig. 1. Thessalian basin in central Greece with the major watersheds.

water purification with the result that the classification of waters is not complete. In the aquatic surface of the Region of Thessaly the net includes 42 sampling points which cover a big part of the total area of Pinios and its parallel torrents. The total number of the sampling points, for concentration inquiry is 30 and the frequency of sampling is seasonal [5]. Supplementary calculations are being made by the Ministry of Agriculture and other agencies [4,8,10,11]. This network has been reconstructed according to the demands of reg. 2000/60/EU and as a product of the results so far [2]. Based upon the shortages and weaknesses of legislation coming from RESP of SD in Thessaly, some measures are proposed to deal with the problem of the rational management and the protection of aquatic resources of Thessaly, as well as solutions for the present problems [5].

3.1. Weaknesses and shortages in legislation

In the regulations proposed for the four Thessaly prefectures, little is included which deals with the utilization of surface waters. Despite the fact that they are irrigated every year with surface water, areas of big land acreage and big or small construction projects (dams, water reservoirs, water purification facilities, etc) for the utilization of surface waters are made, not only by community individuals but also by state administrators (communities). The licenses distributed for usage and construction projects for surface water don't exceed 30–40. On the contrary, via the application of the Greek law 1739/87 the licenses given for usage and construction projects for underground waters exceed 6500, 3500 of which concern Larissa [5]. At the same time, for the control of over pumping and the decrease in expenditure for the use of irrigation water, it is mandatory to gradually establish (in 3–5 years time) in every drilling or water concentration a measurement of provision with which we could control the total annual water consumption possible. The lack of rational and complete management for the totality of water reservoirs especially in Thessaly tempts a lot of engineers to seek help mostly outside the Pinios River basin. The method which has the most advantages is the technological enrichment of ground water aquifers. Since it can store huge quantities of water in natural reservoirs, it decreases the lack of evaporation, it implements simultaneously the antiflooding protection, and it alters the lack of quantities in real water concentrations and not only “available quantities” and finally does not exclude the simultaneous application of other methods [4]. The big problems of Thessaly are intensified by the increasing water demand of cities like Volos and Larissa while “the irrigation of 2.4 million acres in Thessaly and the increase in the water potential of the Pinios River is considered to improve the quality and quantity of the underground waters” with the solution of the river Acheloos diversion in Thessaly becoming uniquely one-way [3,4,12]. Finally, the pollution of aquatic resources [4,6,8,9,14] and especially of the Pinios, is of major importance in Thessaly and this problem is more intense in East Thessaly than in the West and especially in the parallel small forest torrents [14] as of major biodiversity between the unified and ecologically poor areas of monocultivation [5,11]. The first priority is still the remediation of acutely problematic areas like Lake Karla in Thessaly and on certain islands. The expenditure that arises for the new administrators to manage aquifer resources is an optional expenditure [1,4,5]. In Thessaly the parallel river basin forests are small points of major biovariety between the unified and ecological poor area of monocultivations. The program of “nitropollution” in Thessaly has already been approved by the E.U. and is currently being enforced by the Ministry of Agriculture in the edict of 2078/92 [4,6,7,12]. The managing of aquatic resources must be supported as it is claimed in the EP.PER.2000–2006, through the present National Monitoring Network of water quality, the Greek National Bank of hydraulic and meteorological information (GNDBHMI) [1,5] and through the Monitoring Network of the underground waters of Greece (ETIIA) [4,8,9]. The first priority continues to be the intensely problematic areas like Lake Karla's greater area in Thessaly, and certain islands with desalination problems [1,5].

4. Results and discussion

The Greek water sector in Thessaly is very small structured and is controlled by the Governmental and Municipal Services. A very distinguished and important role in the municipalities plays the mayors and the councils of the cities. For the mayors, quality water provision is an important topic to gain people's loyalty, so sometimes they indulge to citizens' demands without taking into consideration the water law. It is obvious that there is a lack of law implementation and that there are weaknesses in the control mechanisms of water usage stage. The usage of surface waters and the construction of facilities for their utilization without a license by citizens, or administrators without basic programming by the state, are still possible. So we propose the following measures.

4.1. Problems of rational management, protection of the aquatic waters and purification and possible solutions

A. *Expression of political will at every level with certain measures. Such measures can be exemplified [11]:* 1. Legislation and decisions. 2. Application of laws and decisions by local water administrators (TOEB, DEYA, etc). 3. Organizational measures and use of police – facilities constructions and utilization of aquatic resources. 4. We can come across regional units, which have been afflicted more than others. Or we can apply an additional methodology using the definition of “environmental sensitivity”: as a first phase (pre-selection, prescreening – scoping, new choices, screening) in the areas which have the greatest environmental problems and afterwards with an increase in the water sample's number as a second phase [5].

B. *Administrative measures – techniques* (installation – establishment of measurements in pumps), 1. Utilization facilities, transfer of surface aquatic resources (river Acheloos, Lake Karla, Lake Smokovos) and enrichment plans for underground aquatic resources [4], 2. Continual information – education of farmers on the ways of saving irrigation water [21], 3. Creation of an administrative center for managing the aquatic resources of Thessaly.

Given all the above problems and weaknesses, water needs will have a more intense antagonistic trait (irrigation, energy, agriculture, environment). Thus, it is critical and obligatory for Thessaly, to create a mechanism (technical–administrative–financial) which will face all the upcoming problems. “If we also consider the serious problems and the weakness we encounter in solving them, since the drought of the years 1977, 1989 and 1991–1992, and since the floods of Karditsa (1994), and in addition the imminent construction of route change plans of the upper side of river Acheloos, then all the above confirm the need for creating a united administrative center for the managing of aquatic resources in Thessaly” [5]. Fortunately the “de-nitrification” program has already been approved by the specific European committee [8,9], reg. 2078/92 and by the Ministry of Agriculture and is being applied to the land of Thessaly [4,6–9,13].

4.2. The prevention of natural water-involved disasters and antiflooding water protection

From all the national operational programs for flood protection, the one which is given the greatest priority is for those areas with a high risk of and/or a great concentration of floods. Prevention is part of planning. It may be characterized more as a program (ex. Ante), than as a plan, as it is immediate planning. The specialized sciences, which deal with these disasters, mention a direct and immediate danger and a decrease in the number of environmental disasters through the alteration of natural phenomena, with a strategy including environmental control, so as to come up with prevention (not excluding the alteration of human behavior). So the first clues are addressed to controlled measurement research, while the behavior with the altered fluctuation in human mortality, becomes a quite difficult problem. As

methodologies in preventing disasters we often use: a watershed of units, the GIS mapping (risk assessment) of a potential disaster for a specific area, the categorization of the disaster in scales, the use of various maps, microzone categorization, disaster models, a digital simulator, and the “Delphi” technique, which is an evaluation method of obtaining what could be considered an intuitive consensus of group expert opinions [4]. Finally, the combination of ‘citizen training’ and the mechanism of crisis management, are what is needed for the prevention of a disaster. Also, in the planning of the prevention we include as a long-term goal the dealing with river basins, either along with other activities, or with some other principles, that concern the protection, the hydraulic convention and the best spatial utilization of the water. Simultaneously, we connect the needs, the characteristics, the qualities and the complexities of the population, with the productive activities and the utilization of water. From RESP of SD in Th, [5,14,15] we conclude with the “technical decision procedure”.

In a large scale and in complete programming/planning we must follow the stages of Fig. 2. For the small scale the consecutive stages and the alternative solutions are based on pre-arranged goals, focusing on the problem, according to the relation in Fig. 2. So, from all the above national operational programs and regional plans it comes out that the antiflooding water protection addresses more specialized fields of expertise, which are concerned with other disasters also and with the diminishing of environmental disasters.

Secondly, it refers to the alteration of natural phenomena, with the strategy of environmental control, so as to achieve prevention [5].

4.3. The need and the goals of a new strategic management of aquatic resources—water purification and policy actions in Thessaly

From RESP, we can conclude that the need for a new strategic management of natural and aquatic resources and policy actions in Thessaly with the reached conclusions, priorities and goals, until 2010, [3,5,9,15] are:

- A) Interventions on demand, usage, water purification and management.
- B) Interventions on the creation of team activities on sustainability, protection and economy of surface waters.
- C) Intervention for the creation of water storage reservoirs.

Priorities of goals until 2010: sufficient and qualitative water supply of urban centers and settlements of Thessalian countryside by “the institution of water management”. Guarantee of minimal necessary environmental benefit for viability in the natural system of Pinios River and its tributaries by “controlling the extension of private

drillings and the over pumping of underground waters” and replacing >1000 millions of m³ of underground reserves caused by over pumping in the period 1985–2000. Maintenance of the viability of rural use can be achieved by new actions of natural rehabilitation of agricultural regions.

The suggested measures: testimonies and confirmations for sanctions of a 2 year-program, for regions with bans and restraining orders for drillings and legalization of the excavations. Confirmation and planning of the water system management of Pinios and water purification. Administrative measures for unauthorized make-shift barriers in the Pinios River and its parallel branches and cost schedule of all irrigational regions upon the infringement management plans and regulations of irrigations of TOEB, Communities and Prefecture Administration. Research of protection and utilization of water resources of Tembi, Kissavos, Pilio, Velestino, and Argitheas–Pindou. Clarification and scientific approval from an interdisciplinary work team, and an inter-science team: concentration, congregation, and evaluation of all ministry studies, services and research administrators for the aquatic resources and activities in Thessaly based on the criteria of performance (financial resources) of environmental purpose (magnitude of natural rehabilitation-funds), of social welfare, of choice by the E.U. funds or the compatibility with the community or national policies [15].

5. Conclusions

A complete integral plan for the aquatic and water purification, soil and natural sources, especially on the coast of the islands, and actions in Thessaly can serve as the strategic goals are improved in relation with older programs and in coordination with the new requirements in demand, use and water management, as well as the interventions for the creation of team works in saving surface waters [4,9,18]. These suggested new strategic goals are based on priorities, and they are addressed by a new strategic environmental management of natural, aquatic sources [21] and actions which can come out of a complete operational plan with the following interventions: The creation of a united administration center for the complete utilization of aquatic resources—water purification and a parallel planning and programming of the same actions. Suggested interventions — actions and legal alterations, for the success of the goals for the natural and aquatic resources and actions but especially for the preservation of viability of agricultural uses and methods for succeeding in the new agricultural frame. Suggested actions toward the expertise of an operational program and plan for inter-professional union for the transfer of the present state to the new goals. These goals are coordinated with the old regional planning in Thessaly as follows:

From the decline of agricultural employment as a best adaptation to the market and multi-functionalism in 2006, to the decline of agricultural employment adaptation to the market and the new division of labor in 2017. From a more balanced interregional progress, with new roles for West Thessaly and the mountain areas in 2006 to a balanced and multi-central interregional development in 2017. From the interruption of degrading and scarce improvements of environmental conditions in 2006, to the accelerated environmental improvement and water purification, a tendency for altering the boosting model with vital elements, in 2017 [4,7].

References

- [1] EP.PER., Operational Environmental programme, Ministry of Environment, Athens, Greece, <http://www.minenv.gr/4/41/4108/g410801.html>, (accessed April 22, 2006), 2001.
- [2] EP.PER.S.D, Operational Environment Programme & Sustainable Development, Ministry of Environment, Athens, Greece, 2004, in Greek.
- [3] E. Koutseris, S. Polyzos, Water resources exploitation—valorization in the context of environmental policies: the case of Smokovo's dam in Thessaly, Proc. of the 6th Inter. Conf. of EWRA, September 7–10, Menton, France, Vol. A, 69A, 2005.

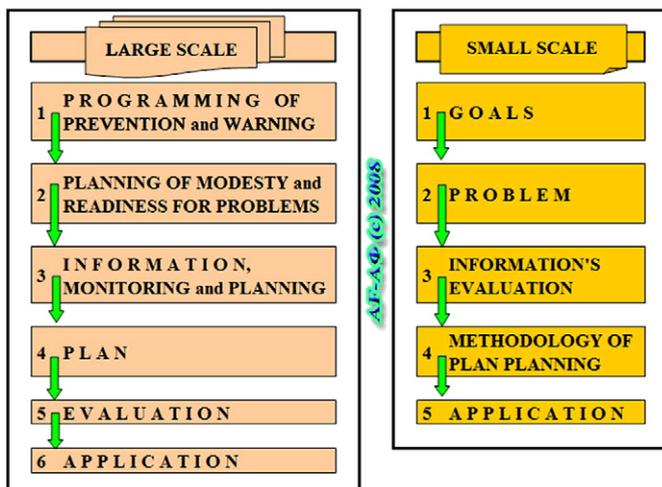


Fig. 2. Large and small scale stages.

- [4] Ag.T., Filintas, Land Use Systems with emphasis on Agricultural Machinery, Irrigation and Nitrates Pollution, with the use of Satellite Remote Sensing, Geographic Information Systems and Models, in Watershed level in Central Greece, MSc Thesis, Department of Environment, Faculty of Environment, University of Aegean, Mitilini, Greece, 2005.
- [5] E. Koutseris, Regional Environmental Strategic Plan of Sustainable Development of Thessaly (RESP of SD in Th): based on the 'Natura' area and water researches management (dir. 2000/60/EU), WTNE of Region Thessaly, Larissa, 2004, in Greek.
- [6] Th. Karyotis, A. Panagopoulos, D. Pateras, A. Panoras, N. Danalatos, C. Angelakis, C. Kosmas, The Greek Action Plan for the mitigation of nitrates in water resources of the vulnerable district of Thessaly, *Journal of Mediterranean Ecology* 3 (2–3) (2002) 77–83.
- [7] Y.PE.XO.D.E. (Tsakiris St. et al.), Frame of regional planning and development of Thessaly Region, Athens, 2002. (in Greek).
- [8] Ag.T. Filintas, P.E. Christakopoulos, G. Stamatis, J.N. Hatzopoulos, An.D. Retalis, D.K. Paronis, Ground water nitrate pollution from agricultural sources in agriculture-dominated watersheds, Proc. of 21st European Conf.-EUC2006 for ESRI users (eds ESRI), November 6–8, Athens, Greece, 2006, pp. 1–14.
- [9] Ag Filintas, J. Hatzopoulos, S. Polyzos, Assessment of surface water springs' quality by the use of GIS and geostatistical techniques, in: G. Arabatzis, S. Polyzos (Eds.), *Natural Resources, Environment and Development*, Tziolas Publications, Thessaloniki, Greece, 2008, pp. 698–728, in Greek.
- [10] M. Podimata, E. Koutseris, N. Tsiropoulos, Water quality assessment by ecotoxicological and chemical methods in Magnesia, Greece, *Water, Air, and Soil Pollution: Focus* 4 (9) (4–5) (2004) 179–187.
- [11] A. Kungolos, P. Samaras, E. Koutseris, Using bioassays for testing seawater quality in Greece, *Journal of Environmental Science and Health A38* (2003) 533–544.
- [12] E. Koutseris, K. Papavassiliou, Water as social and economic commodity: efficacy or conservation sustainability methods, Proc. of the 6th Inter. Conf. of EWRA, September 7–10, Menton, France, Vol. A, 69C, 2005.
- [13] Ag. Filintas, P. Dioudis, Environmental assessment of nitrates pollution of groundwaters' by the use of GIS and Remote Sensing, in: G. Arabatzis, S. Polyzos (Eds.), *Natural Resources, Environment and Development*, Tziolas Publications, Thessaloniki, Greece, 2008, pp. 635–666, in Greek.
- [14] E. Koutseris, Ag. Filintas, P. Dioudis, Environmental control of torrents environment: one valorisation for prevention of water flood disasters, River Basin Management IV, in: C.A. Brebbia, K.L. Katsifarakis (Eds.), *WIT Transactions on Ecology and the Environment*, 104, WIT Press, 2007, pp. 249–259.
- [15] E., Koutseris, Sustainable resources management in the context of agro-environmental EU policies: novel paradigms in Thessaly, Greece, Proc. of the 1st Inter. Conf. on the Management of Natural Resources, Sustainable Development and Ecological Hazards, Transaction on Ecology and the Environment – 'The ravage of the planet' (eds Wessex I.T.), December 12–14, Bariloche, Argentina, 2006, Vol. 99, pp. 197–207.
- [16] EU. Council Directive Concerning the Quality of Water Intended for Human Consumption, 98/83 EC, November 30, 1998.
- [17] W.B. Solley, R.R. Pierce, H.A. Perlman, Estimated use of water in the United States in 1990, US Geological Survey Circular 1081, 1990.
- [18] PEP, Regional Operational Program of Thessaly 2000–2006, Special Management Service PEP, Larissa, Greece, 2000 in Greek.
- [19] EU. Council Directive of 23 October 2002, Establishing a framework for community action in the field of water policy (2000/60/EC) Official Journal of the European Communities, L327 (22 Dec.), 2000.
- [20] EU, Implementation of Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources. Luxembourg: Office for Official Publications of the EC, Brussels, ISBN 92-894-4103-8, 2002, 44 pp.
- [21] Ag.T., Filintas, Study and mapping of biomass yield with the use of spatial statistics and geoinformation, MSc Thesis, Department of Natural Resources and Agriculture Engineering, Agricultural University of Athens, Athens, Greece, 2008.